



Tradeoff Analysis Support for policy-making

Introduction

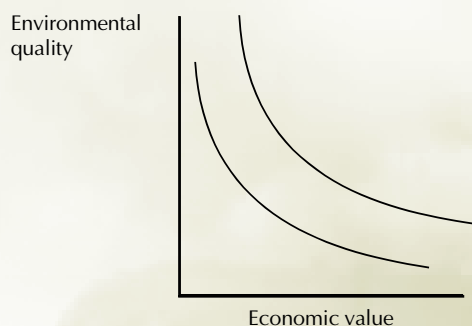
The expression “sustainable development” has become a catchphrase in agricultural research, but little work has been done to measure the sustainability of agricultural production systems. To what extent does agricultural production damage the environment? How do agricultural policies and new technologies affect relationships between agriculture and the environment? Decision makers often have to make choices between these goals based on limited information. Tradeoff Analysis (TOA) helps stakeholders to make informed decisions concerning the dual goals of agricultural production and safeguarding the environment

■ Final product

TOA quantifies the relationship between key economic and environmental indicators. It measures these indicators at the level of a farm field and then aggregates the results from individual fields to watershed or regional levels. The results of the analysis are presented in graphical form. Generally

gains in one area cause losses in another area, and the tradeoff graphs are of the form shown in Figure 1. In some rare cases, there may be “win-win” outcomes where increases in economic value are accompanied by increases in environmental quality.

Figure 1: Tradeoff graphs

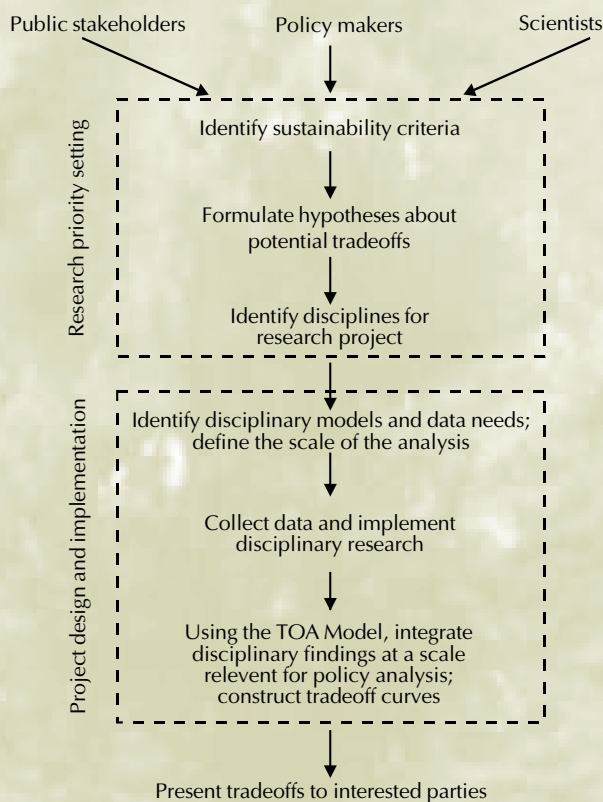


■ Overview of Tradeoff Analysis

TOA is a *process* by which the economic and environmental sustainability of agriculture is analyzed (Figure 2). The process requires participation from various groups that can contribute to informed policy development.

The process begins with public stakeholders, policy makers and scientists identifying the priority environmental and agricultural production problems in a given zone. Based on this, they identify sustainability criteria (health impact, pesticide groundwater contamination, land degradation, value of production, etc). Hypotheses are then generated about the nature of the potential tradeoffs, and researchers from needed disciplines are identified.

Figure 2: Overview of the process of Tradeoff Analysis



The second phase of the process is project design and implementation. First, model and data requirements are identified. Data are then collected and needed disciplinary research is undertaken. Finally, research findings are aggregated to a scale relevant for policy analysis, and tradeoff curves are constructed.

A last critical step in this process is the presentation of the results of this analysis to policy makers and public stakeholders. Concerned individuals and institutions can then use this information to help guide their decision making concerning agricultural and environmental policies.

■ Examples of Tradeoff Analysis research

TOA has been used to study the environmental impact of pesticide use in the potato–dairy pasture system in Carchi, Ecuador, where farmers already make heavy use of pesticides in potato production. Greater use of pesticides increases the economic value of potato production by reducing crop losses, but damages the environment. The two tradeoffs in this case are:

- pesticide groundwater contamination versus the value of potato and milk production
- human health versus the value of production

One of the key findings of this research was that targeting taxes on the most toxic pesticides could create a win–win environmental–economic outcome: improvements in health resulting from decreased pesticide use can improve the labor and management capabilities of farmers which in turn can increase their incomes.

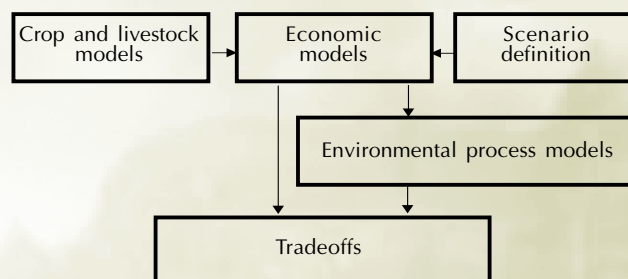
■ Overview of the Tradeoff Analysis Model

The Tradeoff Analysis Model is one component of Tradeoff Analysis. It is an integrated system of quantitative simulation and estimation models that are applied at the scale of a farm field. The Tradeoff Analysis Model comprises the following steps:

1. Geographically referenced data sets of the soil, climate, agricultural and economic factors that influence the decisions of farmers are assembled. With this information, crop growth and livestock models are run using average management practices of the dominant cropping system for the zone under analysis. This provides a measure of the inherent productivity of a field for a given production activity.
2. This measure of inherent productivity is used along with input prices, output prices and fixed production factors in an economic production model that predicts agricultural production, input use and production costs. An initial run of economic regressions “parametrizes” these models, ie, shows how the various explanatory variables affect production and input use.

3. A series of scenarios are defined that simulate i) the impact of a policy that changes output and/or input prices, and ii) the introduction of a new production technology.

Figure 3: Tradeoff Analysis Model components and linkages



4. For a given scenario, simulation analysis shows how changes in prices and technologies affect farmers' decisions on i) land use choices—how much land is put into different crops, and ii) input use choices—the quantity of inputs used to produce a given crop.
5. These land use and input use choices are used as inputs into the environmental model to simulate environmental impacts under different policy and technology scenarios. The changes in prices and technologies also affect economic outcomes such as the value of output production and farmer income.
6. The model estimates economic and environmental impacts for each scenario definition. Plotting the environmental impact on the vertical axis and the economic impact on the horizontal axis gives a result from an individual field.
7. Repeated simulations for a given number of randomly selected fields produces a scatter plot of tradeoff points. A line is then fitted to these tradeoff points, forming a tradeoff curve. This tradeoff curve represents the relationship between environmental and economic outcomes for a given scenario. Specifying a new scenario shifts the tradeoffs curve, causing a change in the relationship between agricultural production and environmental quality.

■ Diffusing the use of Tradeoff Analysis

An international and interdisciplinary team of researchers has developed Tradeoff Analysis (TOA). The institutions involved include Montana State University, the International Potato Center, Wageningen University, the International Fertilizer Development Center, Instituto Nacional Autónomo de Investigaciones Agropecuarias de Ecuador, Instituto Nacional de Investigación Agraria de Perú and various

regional universities in Ecuador and Peru. The TOA research program has been financed by grants from USAID (United States Agency for International Development), IDRC (International Development Research Centre of Canada), and the Dutch–Swiss Ecoregional Fund. A current focus of research is to generalize the Tradeoff Analysis Model so that it can be applied to a wide range of agricultural production systems. The Tradeoff Analysis Model is in a “user shell” which allows the diverse components of the model (crop, livestock, economic and environmental models) to communicate with one another and to aggregate the economic and environmental results into the tradeoff graphs.

Current research in Ecuador and Peru is focusing on the tradeoffs between increased production and land degradation (particularly erosion). Because land degradation progressively reduces the productive capacity of the land, it is also possible to analyze the tradeoffs between current and future production. In this context, TOA will be used to analyze the economic impact of soil conservation practices.

A further objective is to collaborate with other national and international research institutions to conduct TOA in new areas and to train professionals in other research institutions to use TOA themselves. Interested researchers and institutions are encouraged to contact the individuals listed below for further information.

David Yanggen

Montana State University and
International Potato Center
yanggen@cip.org.ec
Telephone (in Ecuador): +593 2 690 362

John Antle

Montana State University
jantle@montana.edu

Charles Crissman

International Potato Center
c.crissman@cgiar.org

Jetse Stoorvogel

Wageningen University
Jetse.Stoorvogel@bodlan.beng.wau.nl

Walter Bowen

International Potato Center and
International Fertilizer Development Center
w.bowen@cgiar.org

Victor Barrera

Instituto Nacional Autónomo de Investigaciones
Agropecuarias
barrera@cip.org.ec



The International Potato Center (CIP) seeks to reduce poverty and achieve food security on a sustained basis in developing countries through scientific research and related activities on potato, sweetpotato and other root and tuber crops, and on the improved management of natural resources in the Andes and other mountain areas



FUTURE
HARVEST

CIP is a Future Harvest Center and receives its principal funding from 58 governments, private foundations and international and regional organizations known as the Consultative Group on International Agricultural Research (CGIAR). Future Harvest builds awareness and support for food and environmental research for a world with less poverty, a healthier human family, well-nourished children and a better environment. Future Harvest supports research, promotes partnerships and sponsors projects that bring the results of research to rural communities, farmers and families in Africa, Latin America and Asia.